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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 210.

Experiment Station Work,

XXVII.

Compiled from the Publications of the Agricultural Experiment Stations.

HEN MANURE.
NITRATE OF SODA FOR FIELD CROPS.
VARIETIES, CULTURE, AND QUALITY OF WHEAT.
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OAK LEAVES AS FORAGE.
THE COVERED MILK PAIL.
CANNING CHEESE.
MILLET SEED FOR HOGS.
FERTILIZERS FOR POTATOES

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK.[a]

PRESERVATION AND VALUE OF HEN MANURE.[b]

Hen manure and poultry manure in general are very rich in fertilizing constituents, especially nitrogen, due to the fact that, in addition to the undigested residue of the food it contains, the urinary secretions, in which are large amounts of nitrogen as well as potash in readily available form, are voided with the solid excrement in this class of animals. The analyses which have been made show that hen manure is very variable in composition, depending upon the stage of growth of the fowl, the character of the feed, and the care taken of the manure. The nitrogen has been found to vary from about 0.7 to 2 per cent, the phosphoric acid from 0.5 to 2 per cent, and the potash from 0.25 to 0.9 per cent. This shows that such manure if properly cared for is much richer than that of other farm animals. It, however, quickly loses nitrogen by fermentation and deteriorates in value if not properly mixed with absorbents or preservatives. Various methods of preventing this loss have been proposed.

The New York Station advises: "When the manure is not used when fresh, it is better to mix it with dry earth, muck, or plaster." The Massachusetts State Station says: "The value of hen manure depends not less on the care which is bestowed on its keeping than on the kind of food the fowls consume. * * * A liberal use of plaster, kieserite, or of good loam is highly recommendable for the absorption of ammonia. * * * A sandy soil is of little use as an absorbent."

A common method is to sprinkle the dropping board from time to time with gypsum (land plaster), and in order to put the droppings into good form for distribution on the soil, to compost them with loam, leaf mold, and similar materials.

The Maine Experiment Station reports comparative tests of kainit, plaster (gypsum), and acid phosphate singly and combined with sawdust as preservatives for hen manure. Three nights' droppings of 180 mature, laying hens, amounting to about 45 pounds, containing when fresh 2.8 per cent of nitrogen, 1.8 per cent of phosphoric acid, and

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Maine Sta. Bul. 98.

0.9 per cent of potash, were mixed with the various preservative materials and stored in barrels from May to November, 1903. An examination at the end of that time showed that—

From the dung stored by itself or with sawdust more than half of this had escaped during the summer. The lot stored with 40 pounds of plaster lost about one-third, while the lot stored with 82 pounds of plaster and 15 pounds of sawdust suffered no loss. The lots with kainit and acid phosphate, both with and without sawdust, retained practically all of the nitrogen. Both because of the danger of loss and its tendency to form into hard lumps, the plaster is less desirable than either of the chemicals tried. The addition of the sawdust materially improved the mechanical condition of the lots so treated. * * *

By itself, hen dung is a one-sided nitrogenous fertilizer. As usually managed, one-half or more of its nitrogen is lost, so that as ordinarily used it does not carry so great an excess of nitrogen. Because of its excess of nitrogen it will be much more economically used in connection with manures carrying phosphoric acid and potash. As both acid phosphate and kainit prevent the loss of nitrogen, it is possible to use them in connection with sawdust or some other dry material as an absorbent (good dry loam will answer [well]) so as to make a well-balanced fertilizer. For example, a mixture of 30 pounds of hen manure, 10 pounds of sawdust, 16 pounds of acid phosphate, and 8 pounds of kainit would carry about 1.25 per cent nitrogen, 4.5 per cent phosphoric acid, and 2 per cent potash, which, used at the rate of 2 tons per acre, would furnish 50 pounds nitrogen, 185 pounds phosphoric acid, and 80 pounds potash.

NITRATE OF SODA FOR FIELD CROPS.[a]

In a previous bulletin of this series[b] attention was called to the profitable use by the New Jersey Stations of liberal applications of nitrate of soda on high-value market garden crops. Since that account was written the experiments have been continued and extended to include field crops of lower commercial value, such as hay crops, wheat, rye, etc. The results of these later experiments show quite conclusively that, provided the soil is well supplied with the other plant-food constituents—phosphoric acid and potash—these lower value crops will also respond profitably to applications of nitrate of soda.

Hay.—The results of experiments conducted through a period of nine years and in different sections of the State show that upon soils which will produce [hay] crops ranging from 1 to 3 tons per acre, a gain in yield of from 9 to 54 per cent, or an average increase of 32.7 per cent, may be expected from the use of from 100 to 150 pounds per acre, which would show an average gain in yield of 654 pounds per acre. Based on the average yield of this section of the country of 1.25 tons per acre, the gain would be 820 pounds. This increase, at an average price of $12 per ton, would mean about $5 per acre, or $2 more than the cost of the material. A very satisfactory profit when it is remembered that it is obtained at the same cost of labor and of capital invested in land. * * *

On good soils, in a good state of cultivation, 150 pounds per acre would be regarded as the most useful amount, though on poor soils, 100 pounds would be better, and on richer soils, as high as 200 or 250 pounds per acre may be used with advantage. The

[a] Compiled from New Jersey Stas. Buls. 164, 172; Rhode Island Sta. Bul. 95.

[b] U. S. Dept. Agr., Farmers' Bul. 162, p. 6.

reason why a smaller amount is recommended on poor soils is because on such soils there is liable to be a deficiency of the mineral elements, and inasmuch as the nitrate is not a food complete in itself, but an element of food, the plant would be unable to utilize it to the best advantage in the absence of the necessary minerals. Where the soils are good, or under the intensive plan, larger amounts may be used, as under this system all the constituents are supplied in reasonable excess, besides every precaution is taken to have the physical condition of the soil so perfect as to provide for the easy distribution and absorption of the food applied. * * *

Apply as a top-dressing in spring after the grass has well started, when the foliage is dry, and preferably just before or just after a rain. If applied earlier than this there will be a slight danger of loss, because the roots will not be ready to appropriate it, and, as it is entirely soluble, it may be washed into the drains. If applied when vegetative functions are active, it is immediately absorbed and not only stimulates and strengthens the plant but causes it to throw its roots deeply into the soil and to absorb more readily the mineral food, and thus utilize to a fuller degree the amount of nitrate applied. * * *

These experiments suggest further that, owing to the difficulty of evenly distributing a small amount of nitrate of soda, and owing, also, to the fact that, on soils that have been seeded with grass, there is frequently a deficiency of mineral elements, a mixture may preferably be used which is rich in nitrate, usually one-half, the balance consisting of acid phosphate, ground bone, and muriate of potash. The soluble minerals are readily carried to the roots of the plants, and the ground bone feeds the surface roots, and the nitrate is absorbed quite as readily as if not used with any other material. This method is to be recommended whenever the land is in good condition and it is desired to keep up the content of the mineral constituents in the soil, as well as to avoid any danger of overfeeding with nitrogen, which would have a tendency, particularly in the warmer climates, of causing a softer growth and formation of mildew. This is liable to occur where the nitrogen is in excess and the ration is not well balanced. A good mixture for top-dressing may be made up as follows:

	Pounds.
Nitrate of soda	500
Ground bone	200
Acid phosphate	200
Muriate of potash	100

Applied at the rate of 200 to 300 pounds per acre.

In cooperative experiments on grass lands made by the Rhode Island Station on eleven farms in that State, top-dressings in April of 350 pounds of nitrate of soda in connection with 300 pounds of muriate of potash and 600 pounds of acid phosphate gave a net gain of $3.90 per acre. "Experiments at the station lead to the belief that the amount of muriate of potash might be reduced to from 200 to 250 pounds per acre, and the acid phosphate perhaps to 500 pounds, without materially lowering the yield and with an increase in the net profit."

Wheat.—[The results of the experiments with this crop at the New Jersey Stations] show a gain in both grain and straw from the top-dressing of nitrate of soda. The yields per acre, without the top-dressing, ranged from 11 to 27 bushels of grain per acre and from 1,500 to 1,800 pounds of straw, thus showing a wide variation in the character of the soils used and in seasons, making the average of the results generally applicable.

The gain in yield of grain ranged from 25.9 to 100 per cent, while that of straw

ranged from 54 to 100 per cent, or an average of 60.8 per cent increase in the case of the grain and 83.8 per cent increase in the case of the straw. The value of these increased yields, at average prices, shows a large profit in all cases. * * * The experiments show that on soils in a good state of cultivation, those that will produce from, say, 15 bushels per acre without top-dressing, 150 pounds per acre, the average amount used in the experiments, would be the most useful, though on poorer soils, which would average 10 to 12 bushels per acre, 100 pounds would be better for the reasons already discussed in the case of hay.

On better soils, where quantities larger than 150 pounds per acre seem desirable, it is strongly recommended that two applications of equal weight be made; the first, when the plants have well started, and the second, when the crop is coming in head. Very often the season is such as to encourage a rapid change of the insoluble nitrogen in the soil, in which case too large an application in the spring would tend toward an undue development of leaf and the ripening would be impaired; hence the advantage of dividing the amount is apparent, as, if the season is good and the growth normal, the second application may be dispensed with. Where the soil is liable to be deficient in minerals—and this is often the case—the nitrate may be mixed with other materials, as recommended for hay, the excess of minerals not used for the wheat providing for the following crop.

Rye.—The three experiments with rye in 1894 confirm the conclusions reached in both the experiment on hay and wheat, that nitrate of soda as a top-dressing proves desirable in effectually increasing the yield of both grain and straw, and which is accomplished at a profit. The average yield of crops without top-dressing ranged from 9.3 to 15.4 bushels of grain, and the increase from the application of 100 pounds of nitrate of soda ranged from 21 to 37 per cent for grain and from 33.5 to 37 for straw, or an average increase of 28.5 per cent for grain and 35.7 for straw. The yield obtained without top-dressing is not so large as in the case of the wheat, nor is the increase proportionately as large, due undoubtedly to the facts that the rye is usually grown on poorer land than wheat, and that only 100 pounds were used, though this small amount was recommended because of the relatively lower price of grain. [A net gain of nearly $4 per acre from use of nitrate is indicated.] * * * The suggestions as to the amount and time to apply are practically the same as for the wheat and hay, though, owing to the fact that the straw is relatively more valuable than the grain, the larger applications may be made for the rye than for wheat, as an abnormal increase in the proportion of straw would not result in lowering the total value of the crop.

Forage crops.—During the years 1899 to 1902 seven experiments were conducted with nitrate as a top-dressing on forage crops [rye, wheat, barley, barnyard millet, corn, oats, and peas], the nitrate being used in addition to the manures and fertilizers generally [applied]. * * * In all cases a very marked increase due to the application of nitrate occurred, ranging from 34.1 per cent for corn to 96.6 per cent for barley—a profitable return from the use of the nitrate on all crops except the barley, which, owing to unfavorable weather conditions, did not make a large yield. * * * The value of the increased crop ranges from $5.64 to $11.59 per acre—a profitable increase in every case, as the average cost of the nitrate did not exceed $3.60. This profit does not take into consideration the fact that the average increase for all the crops was over 50 per cent, thus reducing, in this proportion, the area required for the production of a definite amount of food, a point of vital importance in the matter of growing forage for soiling purposes. In other words, it is shown that not only is there a profitable gain, but that with these crops the application of nitrate of soda made it possible to double the number of cattle or the number of cows that could be kept on a definite area. * * *

In the case of the wheat and rye, the application was made when the plants were

well started in the spring. In the case of the spring or summer seeded crops the applications were made after the plants were well started and root systems well established and ready for the rapid absorption of food. In raising forage crops the best results—in fact, satisfactory results—can only be obtained when grown under the intensive system. The soil must be well prepared and an abundance of all the elements of plant food supplied. Hence, the application of nitrate may be greater than is usually recommended for grain crops under the extensive system.

Among the fundamental facts brought out by these experiments is the necessity of applying the elements of plant food liberally in order to secure maximum crops.

Of these constituent elements nitrogen is of especial importance, because it is the one element which, in its natural state, must be changed in form before it can be used by the plants. Hence, its application in an immediately available form is especially advantageous for quick-growing vegetable crops, whose marketable quality is measured by rapid and continuous growth, and for those field crops which make their greatest development in spring, before the conditions are favorable for the change of the nitrogen in the soil into forms usable by plants. * * *

Many crops, as, for example, those grown for early spring forage or for hay or grain, as rye, wheat, timothy, orchard and other grasses, are unable to obtain the nitrogen from soil sources early enough to permit of a rapid and maximum development; the agencies which promote the activities which cause a change of organic forms of nitrogen into nitrates are dormant, hence an application of nitrogen in a completely soluble and immediately available form supplies the plant with what it needs at the time of its greatest need, and great gains in yield are made. In the culture of early market-garden crops, too, or such as are improved in quality, and thus increased in value, by virtue of quickness of growth, the nitrate is of the greatest service. Such crops as tomatoes, cabbage, turnips, beet, and others, in order to be highly profitable, must be grown and harvested early, as anyone can grow them in their regular season; their growth must be promoted or forced as much as possible in a season when the natural agencies are not active in the change of soil nitrogen into available forms, and the plants must, therefore, be supplied artificially with the active forms of nitrogen if a rapid and continuous growth is to be maintained. Their edible quality is dependent, to a marked degree, upon this rapidity of development; hence a supply of plant food in reasonable excess of ordinary demands is essential, in order that unfavorable conditions of season may, in part at least, be overcome.

VARIETIES, CULTURE, AND QUALITY OF WHEAT.[a]

A. M. Soule and P. O. Vanatter, of the Tennessee Experiment Station, have reported results of experiments on the station farm with 48 varieties of winter wheat extending over four years, "undertaken with a view to determining if possible what varieties of wheat are best adapted for cultivation in Tennessee, the relative merits of these varieties for flour and bread making as compared with wheats grown in other parts of the country, the possibility of improving varieties through selection and plant breeding, and finally the introduction and dissemination of varieties that might be of greater value than those generally cultivated." Of the 48 varieties tested only a limited number are recommended for general culture.

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[a] Compiled from Tennessee Sta. Bul., Vol. XVI, No. 4.

Poole made the highest yield in 1903—48.5 bushels; the average for four years was 37.23 bushels. Niger made 44.27 bushels in 1903 and averaged 36.77 bushels for four years. Fulcaster produced 39.27 bushels in 1903 and averaged 36.2 bushels for four years. Mediterranean made 42.55 bushels in 1903 and averaged 36.18 bushels for four years.

Early Red Clawson, White Wheat No. 6, Winter King, Eclipse, New Monarch, Gold Coin, Dawson Golden Chaff, American Bronze, and Beardless Fulcaster have been discarded after four years' trial as unsuitable varieties for this State.

Poole is the only variety brought from outside the State that can be recommended for general culture.

Some of the reasons for the low yields reported by Tennessee farmers are, a failure to rotate and to prepare the seed-bed properly, a deficiency of vegetable matter in the soil, late seeding, and unsuitable varieties.

The climate and soil of Tennessee favor the production of wheats containing a very high percentage of protein. The average percentages of protein in Mediterranean and Fulcaster were 17.39 and 17.00, respectively, at the end of four years. All the varieties were high, Dawson Golden Chaff being lowest, with 13.19 per cent.

The season has a marked influence on the protein content. Beech Wood Hybrid contained 21.92 per cent in 1900, 13.77 per cent in 1901, 15.74 per cent in 1902, and 15 per cent in 1903. This is only one of many examples.

The protein content was highest in 1900 and 1902, years when the rainfall was somewhat deficient during the ripening period. This gave a short, quick ripening period, retarding the elaboration and transference of the starch from the stems to the grains and so increasing the protein content. The climatic peculiarity noted accounts largely for the high protein content of Tennessee wheat.

A rich soil or the use of large quantities of commercial fertilizer or farmyard manure does not seem to increase the protein content of wheat to an appreciable extent.

The percentage of flour produced by Tennessee wheat is high, the leading varieties being equal or superior to those most commonly grown and highly esteemed in other sections. Fulcaster ranged from 70 to 75 per cent and averaged 73.4 per cent.

In color some of the hardest varieties are not quite equal to some of the white, soft wheats produced in other sections, but the hard varieties produced in Tennessee are equal in merit to those produced in other sections. As the hard varieties produce much more gluten, and are better adapted to Tennessee conditions, and are preferred by the millers, farmers would do well to cultivate them more extensively; for the flour can be materially improved in color by being properly baked.

The number of loaves per barrel obtained from Tennessee flours equals or exceeds the number obtained from wheat grown in other sections.

The loaf obtained from Tennessee flour is apparently not quite so large as that obtained from the flour of Minnesota spring wheat, but the difference is slight.

The difference in quality of gluten is not so important as might be thought at first because the yield of the hard wheat is much greater and the gluten content of the flour from hard wheat is higher than from soft wheat. This explains why the millers prefer Fulcaster and Mediterranean, and why these varieties are more desirable for general culture in the State than soft, white wheat.

To maintain and improve the "standard" of a variety the seed must be carefully graded and selections made from the best type heads in the field. Large increases will not be obtained by this method, but the variety can be maintained indefinitely and adapted to local conditions.

A large increase in yield will not be obtained immediately by the selection from type heads, and the work should not be undertaken unless it can be systematically carried on through a series of years.

Fertilizers give their best results on a soil well supplied with vegetable matter. It

is easy to use fertilizers at a loss with wheat unless the character of the soil is well understood.

Many impoverished soils can be made profitable for wheat production by the plowing under of cowpeas and the liberal application of phosphates, potash, and lime. Soils tilled for many years are often acid, and lime corrects this fault.

Farmyard manure applied at the rate of 15 tons to the acre increased the yield of wheat on bare fallow 10.71 bushels in 1902. Fertilizers alone on a poor soil failed to increase the yield more than from 3 to 5 bushels, and in a dry season they were used at a loss. When cowpeas were plowed down the increase varied from 5 to 11 bushels in a favorable season and from 3 to 8 in a dry season. Cowpea when sown as a "catch crop" can be counted on to increase the yield of wheat several bushels per acre.

BREEDING CORN OF SPECIAL COMPOSITION.[a]

The importance of breeding corn for special purposes—for high protein, oil, or starch—and the progress made in this line of work,

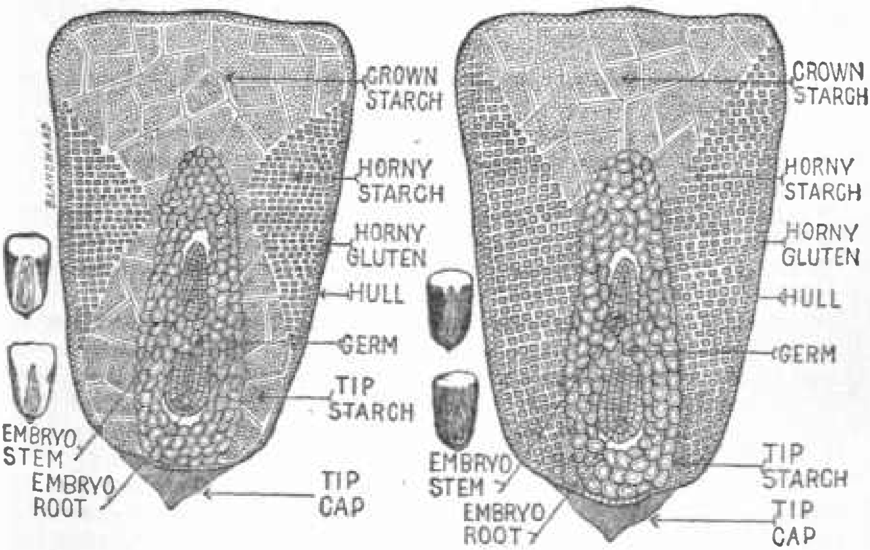

FIG. 1.—Low-protein (on left) and high-protein (on right) corn kernels.

especially at the Illinois Station, were briefly referred to in a previous bulletin of this series.[b] As Dr. C. G. Hopkins of that station states—

> It is a well-established fact that there now exist markets and demands for different kinds of corn.
>
> The price of corn varies, say, from half a cent to 1 cent per pound.
>
> The cost of protein in the principal stock-feeding States varies from 3 to 5 cents per pound. In other words, the protein is several times more valuable per pound than corn itself. Consequently, stock feeders want more protein in corn. Very possibly the feeders in the Southern States want more carbohydrates to supplement their present more abundant supplies of nitrogenous food stuffs.
>
> The price of cornstarch varies from 2 or 3 cents to 5 or even 10 cents per pound,

[a] Compiled from Illinois Sta. Buls. 53, 55, 82, 87; Kansas Sta. Bul. 107.

[b] U. S. Dept. Agr., Farmers' Bul. 193, p. 25.

depending upon the wholesale or retail nature of the sale. The manufacturers of starch and of glucose sugar, glucose sirup, and other products made from starch want more starch in corn.

With corn oil worth 5 cents per pound it can readily be seen that a high-oil corn would be in large demand. On the other hand, corn with a lower oil content is desired as feed for bacon hogs, since it has been shown that ordinary corn contains too much oil for the production of the hard, firm bacon demanded by our export trade.[a]

The Illinois Station has made a very thorough study of the structure and the composition of the different parts of the corn kernel, with a view to working out practical methods of selecting seed with reference to composition. Summing up these investigations, it is stated that "the kernel of corn consists of 6 readily observable and distinctly different physical parts, which are known as (1) the tip cap, (2) the hull, (3) the horny gluten, (4) the horny starch, (5) the white [crown] starch, and (6) the germ." (See fig. 1.)

The tip cap covers the tip or base of the kernel and comprises only about 1.5 per cent of the grain.

The hull is the very thin outer coat. It comprises about 6 per cent of the kernel and contains a lower percentage of protein (about 4 per cent) than any other part of the kernel.

The horny glutenous part (aleurone layer) lies underneath the hull surrounding the kernel. It comprises from 8 to 14 per cent of the grain (being more abundant in high protein corn), and it contains from 20 to 25 per cent of protein, being the richest in protein of all the parts of the corn kernel.

The horny starchy part is the chief substance in the sides and back of the kernel (the germ face being considered the front of the kernel). This substance comprises about 45 per cent of ordinary corn, but is much more abundant in high protein corn and less abundant in low protein. Although rich in starch, it contains about 10 per cent of protein (more in the high protein corn and less in low protein corn). It contains a greater total amount of protein than any other part of the kernel.

The white starchy part occupies the center of the crown end of the kernel and usually partially surrounds the germ. It comprises about 25 per cent of the kernel (less in high protein corn and more in low protein corn.) It is poor in protein (5 to 8 per cent).

The germ occupies the central part of the kernel toward the tip end. It comprises about 11 per cent of the kernel (more in high oil corn and less in low oil corn). The germ contains from 35 to 40 per cent of corn oil, or from 80 to 85 per cent of the total oil content of the corn kernel.

High protein corn contains a large proportion of the horny parts (both of the horny glutenous part and the horny starchy part) and a correspondingly smaller proportion of the white starchy part. The horny parts comprise more than 60 per cent of high protein corn, and contain about 80 per cent of the total protein content of very high protein corn.

The method of selecting corn by mechanical examination for improvement in composition, which has been very successfully used by the

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[a] U. S. Dept. Agr., Farmers' Bul. 162, p. 26.

station and practical farmers and corn breeders, is based upon these facts and is in brief as follows:

Remove from the ear a few average kernels; cut two or three of these kernels into cross sections and two or three other kernels into longitudinal sections and examine these sections as they are cut, usually simply with the naked eye.

If selecting seed ears for high protein content, save those ears whose kernels show a small proportion of the white starch immediately adjoining or surrounding the germ. If selecting corn for low protein content, look for a larger proportion of white starch surrounding the germ. The white starch in this position—that is, surrounding the germ toward the tip end of the kernel—is a better index of the protein content than the starch in the crown end.

If selecting seed ears for high oil content, save those ears whose kernels show a large proportion of firm and solid germ; while, if seed of low oil content is desired, look for a small proportion of germ in the kernel.

It should be emphasized that it is not the absolute, but proportionate, size or quantity of germ or of white starch which serves as a guide in making these selections.

Of course the importance of also giving attention to the factors which combine to produce a large yield should not be lost sight of. Only a variety which is satisfactory in this respect should be selected for breeding for special composition.

EFFECT OF IRRIGATION ON THE QUALITY OF CROPS.[a]

In crop production as a rule more attention is given to increasing the yield than to improving the quality of the product. In the majority of cases it is the maximum crop rather than the optimum quality which is sought in practice. With the adoptiou of more intensive systems of farming, more exacting demands of the markets, and the growth of competition in agricultural production, it is becoming more evident that both of these factors must be taken into account, and that the most successful farmer will be the one producing the largest crops of the best quality. A great deal of the work of the experiment stations is directed toward this end. Recently the Utah Experiment Station has reported some interesting studies of the effect of irrigation on the composition and quality of crops. Heretofore the experiments in irrigation have been directed very largely toward determining the amount of water required to produce a given amount of crop (the so-called "duty of water") without much reference to the quality of the product. Such experiments have been of great value in determining the exact quantity of water required to produce a given weight of different crops. Some results of experiments of this kind by the Utah Station are shown in figure 2. The experiments of this station, however, dealt with the amount of water which would produce the best crop as well as the largest crop. The experiments were made on shallow, gravelly bench lands with wheat, oats, corn, potatoes, and sugar beets.

[a] Compiled from Utah Sta. Buls. 80, 86.

The results with wheat show that—

The yield of grain and straw per acre increases as the amount of water increases up to a certain limit. If more than 30 inches are applied, the yield, both of grain and straw, diminishes. * * * The wheat raised with least water [5 inches] contained the highest proportion of gluten, and as the amount of water used increased the amount of gluten decreased steadily. Unquestionably, therefore, the most desirable wheat for human use is that raised with little water. This may account for the preference given "dry-farm" wheat by the millers of the State.

In the case of oats there was a steady increase of grain and straw until 30 inches was applied; more than 30 inches caused a decrease.

Oats and other grain crops spend the early periods of their lives in developing strong roots, stalks, and leaves, and storing in these organs numerous compounds obtained from the soil and air. At a certain period, known as the time of flowering, this process stops, and the materials accumulated by the plant are largely dissolved by the plant juices and transferred to the organs of reproduction, where the seeds are

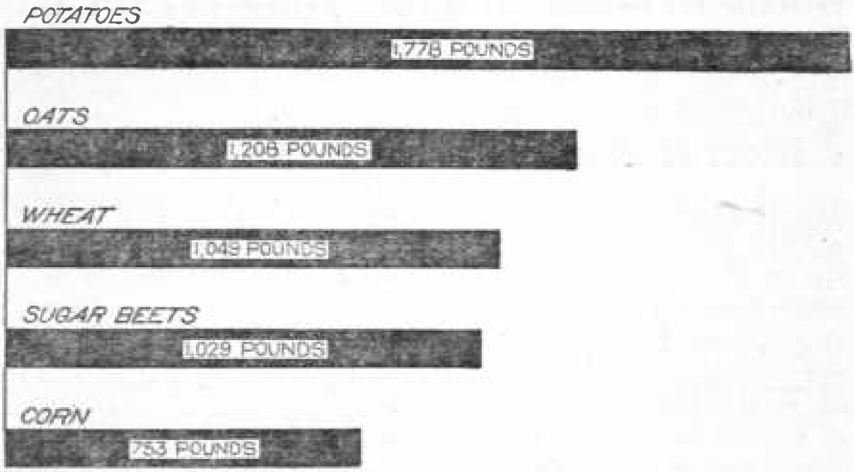

FIG. 2.—Water required to produce 1 pound of dry matter in different crops.

formed. During this period of seed building the plant needs an ample supply of water with which to transfer, readily and continuously, the nutritive materials from the leaves, stalks, and roots to the seeds. It would, therefore, be supposed that heavy irrigations at the time of "heading out" and later would result in large seed production. * * * [In the station experiments] two plats received the same total amount of water in three irrigations, but one received a heavy irrigation early [7½ inches], and a light irrigation at the time of heading out, while the second received the light irrigation first and the large one last. The large irrigation at the time of seed formation gave 65 bushels of grain as against 49 bushels when a light irrigation was applied late. It is most interesting to note that the increase in grain was obtained at the expense of the straw, which decreased correspondingly. In order to obtain the largest yields of grain, oats and all other grain crops should receive heavy irrigations at the time of heading out. * * *

The yield of ear corn, and, with one exception, of stover, increased with the increase of water. In this respect corn appears to be different from the other grain crops, wheat and oats. However, the increase per inch of water, after 20 inches had

been applied, was very small indeed. * * * Varying the amount of irrigation water applied affects not only the total yield of crops, but also the manner of growth and the quality of plants. A striking confirmation of this statement is the proportional increase of the seed produced by grain crops by increasing the amount of irrigation water. For instance, in the corn experiments * * * [the] results show clearly that liberal irrigation tends to increase the grain at the expense of the straw. Similar, though not so striking, results were obtained with wheat and oats. * * *

The yields of potatoes increased uniformly, with one exception, as the quantity of water was increased. With 40 inches of water more than four times as many potatoes were produced as with 9 inches. It is evident that the potato is a crop that demands much water for the production of maximum yields. * * * [However], the same amount of water [15 inches] when applied in six irrigations gave nearly two and one-half times as many potatoes as when applied in two irrigations. Potatoes should, therefore, receive frequent small irrigations. * * * The proportion of marketable potatoes was largely increased by frequent small applications of water. Only a little more than one-half of the potatoes raised with two irrigations were marketable, while nearly nine-tenths of those raised with six irrigations were suitable for the market. Few heavy irrigations tend to produce small potatoes; frequent small irrigations tend to produce large potatoes. * * * With 9 inches of water only 41 pounds in every 100 pounds of potatoes were marketable; with increasing applications of water the proportion increased until, with 40 inches of water, 91 pounds in every 100 were marketable. This is a most emphatic argument in favor of liberal irrigations in potato farming. * * * The proportion of starch increased up to 20 inches with the amount of irrigation. * * * Frequent small irrigations yielded starchier potatoes than did large and infrequent irrigations. The proportion of protein was larger in potatoes raised with less water than in those raised with more, but since potatoes are nearly always eaten with meat or some other food rich in protein, there is no particular need for potatoes that contain a high proportion of this substance at the expense of the starch. All the evidence tends to confirm the conclusion that large yields of marketable, starchy potatoes are obtained with frequent small irrigations, the total quantity of water applied being as large as possible. * * *

From 14 to 20 inches, 1 ton of sugar beets is obtained for each inch of water applied. If more than 20 inches be applied there is no gain, and if more than 25 inches there is a decrease in the yield of beets. On deep soils less than 20 inches of water will probably give maximum yield of beets. * * * Not only does the moderate use of water (about 20 inches per season) give the largest yield of beets, but it produces also beets that are richer in sugar than either those grown with less or more water. * * * The results of the analyses of the beets grown in the irrigation experiments [show that] an increase of 1 per cent of sugar was obtained by employing about 20 inches of water in irrigation. Such an increase would mean to a factory handling 25,000 tons of beets nearly one-half million pounds of sugar, which is certainly an item worthy of consideration. From every point of view the moderate use of water in the irrigation of sugar beets appears desirable.

THE EFFECT OF SHADING STRAWBERRIES AND VEGETABLES.[a]

Considerable interest has been manifested in recent years in the subject of artificial shade for growing crops. Lath sheds affording partial shade have been found to improve greatly the quality of pine-

[a] Compiled from New Jersey Stas. Rpts. 1897, p. 344; 1899, p. 362; New York State Sta. Bul. 246; Amer. Agr., 70 (1902), No. 22, p. 595; Gardening, 12 (1904), No. 273, p. 517.

apples grown in Florida, besides affording protection from frost. In several localities considerable success has also been attained in growing certain fine grades of tobacco under cheese-cloth shade where without such shade the high quality could not be produced. The success attained and the value of shade in the culture of these crops have led growers in some sections to test its influence on certain vegetables and small fruits, and it is probable that the extent and limits of the uses of shade for such crops will soon be determined. It is the purpose of the present article to summarize briefly the work thus far reported in shading these latter crops.

Strawberries.—One of the most comprehensive experiments in shading is that reported by the New York State Experiment Station with strawberries. The work covered two seasons, 1902 and 1903. The season of 1902 was unusually wet and therefore poorly adapted to show the merits of the system, but that of 1903 was dry and especially favorable for a fair trial. The material used for shading was a thin kind of cheese-cloth known as "Bombay," costing about 4 cents a yard, and when sewed together and hemmed, with rings attached for securing it, the first cost was at the rate of about $350 per acre. This cloth was stretched over wires about 20 inches above the ground. A heavier grade of cheese-cloth was used in one experiment.

The strawberry plants developed normally underneath the shade. "The matted rows in the shade were better filled because the plants made more leaves and larger leaves, and because no plants under the cover were killed by the drought, while some in the open were killed and many were seriously weakened." As the result of heavy frost it was observed that many of the leaves and all of the buds of any size not under the cover were killed, while underneath the cover none of the leaves were injured. The injury to the buds of Wilson and Haverland varieties was as follows: With Wilson only 8.6 per cent of the shaded buds were injured, while 80 per cent of those not shaded were injured; with Haverland 6.5 per cent of the shaded buds were injured, while of those not shaded 89.4 per cent were injured.

As regards yield, only when thin cheese-cloth was employed was there any increase; with the heavier grade of cloth there was a marked decrease in yield with each of the 20 varieties grown, and in no case was the increase in yield sufficient to compensate for the cost of shade. In the case of the lighter grade of cheese-cloth there was a considerable increase in the size of the berries obtained under shade, but with the heavier grade no difference in size of berries was observable. With the lighter grade of cheese-cloth 13 quarts picked underneath the canvas contained 1,102 berries, while 13 quarts picked in the open contained 1,452 berries, thus showing an increase of about one-third in size in favor of the shaded berries.

Under the thin cheese-cloth a few of the berries ripened a little earlier than the same varieties in the open, but the bulk of the crop ripened at about the same time as outside. Under the heavy grade of cheese-cloth the period of ripening was retarded from 1 to 3 days for some varieties, while other varieties were not affected. The shaded berries appeared to be a little brighter and glossier than those grown outside, but the difference was not marked. The texture of the berries was not noticeably different, except in the case of Marshall, which appeared to be softer and more melting in the mouth than those grown outside. Shaded Ridgeway berries were also softer than those grown outside, and their shipping quality was injured.

Analyses of the Marshall and Ridgeway varieties showed that the berries grown under shade were slightly less acid than those grown in the open, and also contained a smaller percentage of sugar. Shading appeared to increase slightly the susceptibility of the strawberry plants to leaf blight, and in one case more mildew was observed under the cheese-cloth than outside.

In the experiments careful measurements and observations were made to determine the effect of the cover on external conditions as well as on the plants themselves. Generally speaking, the temperature of the air underneath the cloth was a little higher than outside. This was especially true on bright, sunshiny days. For the whole period the temperature underneath the cloth averaged 2.8° higher than outside. The temperature of the soil averaged 1.4° warmer in the morning and 1° warmer at night under the cover than outside. The ground was slightly more moist and the air more humid under the cloth than outside. The cloth tempered the effect of the wind so that when a stiff breeze was blowing outside there was not enough wind under the cover to move a sheet of paper lying on the ground. The intensity of light was considerably modified by the covering, while the evaporation was diminished about half. It is believed, however, that "the shading was far less effective in conserving moisture than mulching or tillage would have been, and availed but little in overcoming the effects of drought."

On the whole the results of the experiment during the two years indicated in general only a limited usefulness for the practice of shading as applied to strawberries. "It is possible to grow larger berries, berries of better quality, and especially with some varieties berries of better appearance, but in the tests the berries were no earlier and the quantity of fruit was decreased or increased far too little to pay the extra expense of shading. * * * For general field culture to ship or to sell at general market prices, the expense of shading would be a complete loss, as shown by the results with most of the varieties."

Vegetables.—The experimental work reported on shading vegetables is not very extensive. Professor Macoun, of the Central Experiment Station in Canada, has reported an experiment along this line, carried out in 1903. Under a tent made of cheese-cloth he grew a large number of different vegetables. The summer of the test was cool and wet, and the results secured were probably much less favorable than they would have been in a better, drier season. The same kinds of vegetables were grown just outside of the tent for comparison. With lettuce the plants were two to four days later in maturing under the tent than outside. With beets the tops grew as well inside as outside the tent, but when the crop was pulled it was found that the roots of the crop grown outside weighed 22½ pounds, while those grown inside weighed only 9 pounds. Radishes appeared to be slightly benefited by the shade. They were ready for use inside the tent fully three days before those outside and were perfectly free from maggots, while those grown outside were practically worthless from this cause. Inside the tent the radishes grew to a large size before losing their crispness. Beans also were ready for use three days earlier inside than outside the tent. The plants were equally vigorous, but the yield was slightly greater from the plants grown outside the tent. Cauliflower grown in the open was attacked badly by the root maggot, while plants grown under the tent were free from this pest. Cucumbers grew well in the tent, but no fruit set until late in the fall, when the tent became torn and a few insects were thus admitted. There was only a small crop outside owing to the unfavorable season. Tomatoes ripened six days earlier under cloth than outside. The yield, however, was 55 pounds 2 ounces for the crop grown in the open and but 15½ pounds for the crop inside the tent. Corn grew more rapidly inside the tent than outside at first, but later was not so robust. Late frost, which affected vegetables outside the tent, did not affect those grown inside. The average temperature inside the tent was slightly higher than that outside, the greatest difference in any one case being 9°.

In conclusion, Professor Macoun states that "the cheese-cloth inclosure may be of value in cities and towns where it is difficult to have a garden owing to the injury done by cats, dogs, and even young children. Vegetables will probably be tenderer, as a rule, grown inside an inclosure, though this was not the case this season owing to the wet weather. It may be useful to market gardeners for growing vegetables which are affected by root maggots."

An experimenter in Connecticut reports that cucumbers, watermelons, and muskmelons grown under shade were not a success. The vines grew well, but the fruits were small. In the case of cucumbers a few reached small pickling size. The melons did not do as well.

He states that strawberries, however, on Long Island were two weeks earlier under cloth than out of doors. Another grower at the same place reports that cucumber, watermelon, and tomato vines grew better under the tent than outside, but yielded hardly any fruit, and the little that set shriveled up. Another grower in the same locality states that he grew muskmelons and cucumbers under cloth, but found no advantage in the practice over outdoor culture. The tent shelter did not protect the vines from mildew or blight.

At the New Jersey Stations Professor Halsted reports the effect of growing a large number of vegetables under lath frames, the space between the laths in each case being equal to the width of the lath, so that the plants were really in half shade. Early planted Lima beans were retarded by the shade, but those planted later in the summer, when the ground was hotter, germinated more quickly underneath the shade than outside. The first crop of peas germinated sooner and produced more pods in the open than under the screens. The second crop of peas was also more fruitful in the open. No difference in germination was noticed. Shaded carrots produced more foliage but much smaller roots than unshaded ones. With lettuce, however, shaded plants of the second crop were much larger and better than unshaded ones. It is believed that shading will be found of great benefit in growing midsummer lettuce. Swiss chard gave results similar to those with lettuce, and in addition the injury from leaf blight was reduced. Celery was affected by shading more noticeably than any other plants. "Six varieties were tested in this way, and all grew to more than double the size of other plants of the same lot that were in the full sun; but later in the season, with shorter days and less light, the exposed plants overtook and surpassed the shaded ones." Six varieties of bush beans produced a somewhat greater weight of pods under the screens than outside, but the proportion of ripe pods in the sun was much greater than in the shade.

Club root of turnips and scab of potatoes were not reduced by shading. Blight of carrots was apparently checked by shading. As with the vegetables grown under the cheese-cloth tents, the shaded plants were unaffected by the first few frosts in the fall, which killed the exposed plants. The temperature under the screens, however, was from 4° to 11.6° cooler under the screens than in the open air, the difference increasing as the summer advanced.

All in all the data so far obtained do not warrant any general conclusions in regard to the value of artificial shading. But the practice does not appear to be sufficiently promising to make it worth while trying on the farm until the details have been more thoroughly worked out.

INJURIES TO SHADE TREES.[a]

Dr. George E. Stone, in a bulletin of the Massachusetts Experiment Station, calls attention to the increasing interest in recent years in shade trees and roadside improvement, and to the good results from the renewed interest in tree planting. He also points out the many adverse conditions with which shade trees have to contend and which "are likely to increase with the development of our cities and towns along present lines." Among these are—

FIG. 3.—Disfigurement of trees, caused by electric wires.

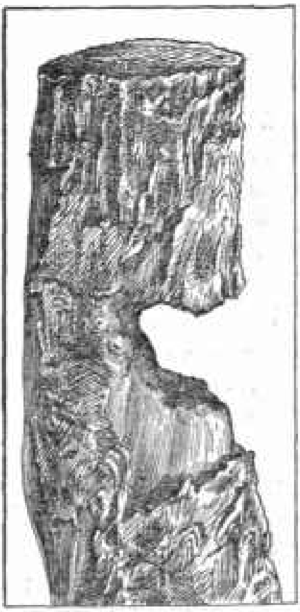

FIG. 4.—Deep burning of a large limb, caused by an alternating current of high potential.

Interference with soil moisture and root respiration by paved and macadamized roads and sidewalks; destruction of the root system by excavations for buildings, sewers, water, gas, and steam pipes; interference with the root system by earth fillings and regradings; abnormal physical and chemical conditions of soil made up of refuse material, and of unsuitable soil texture causing an insufficiency or oversupply of soil moisture; effects of soil covers as affecting water supply, etc.; injuries arising from horses' teeth, abrasions from teams, etc.; effects of exposure to various obnoxious atmospheric gases and smoke; lack of aseptic and antiseptic treatment in cases

[a] Compiled from Massachusetts Sta. Bul. 91.

of wounds arising from accidental or intentional pruning, or from injuries from horses' teeth, abrasions from teams, etc.; interference with tree growth by telephone wires; electrical injuries due to contact with alternating and direct current wires; injuries due to leaks in gas mains, steam conduits, etc. Insect and fungus pests are [also] frequently troublesome.

These conditions, singly or combined, constitute a serious menace to the life or normal development of trees. Of the factors named Doctor Stone has made a special study of injuries due to electricity.

The increase of electric railroads, electric-lighting systems, and telephone lines, which have their wires located usually adjacent to the tree belt, necessitates a large

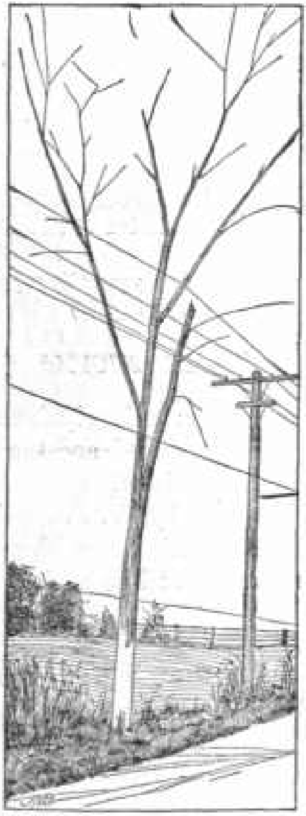

FIG. 5.—Elm tree killed by a direct current from an electric railroad system carrying positive current in the rail and return current in the so-called feed wire in contact with the branches.

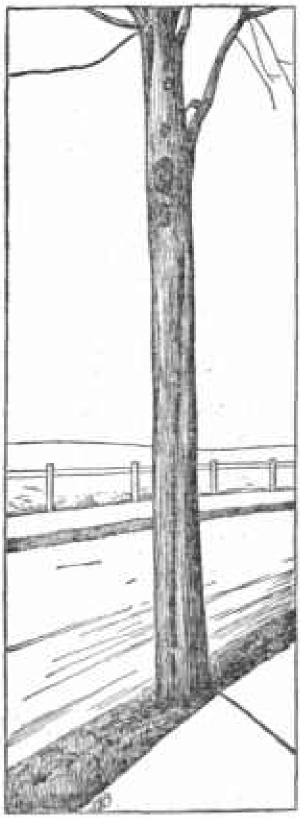

FIG. 6.—Effect of earth discharges of lightning through a tree, causing splitting of the trunk and destruction of limbs.

amount of disfiguration by pruning, and the close proximity of wires to trees too frequently causes a serious injury to them in other ways. A tree that has been severely pruned, or disfigured by a mass of wires is scarcely better than none. (Fig. 3.)

A considerable amount of damage occurs to shade trees by wires, causing abrasions, destruction of limbs and leaders, burnings, and necessitating much injudicious pruning.

The greatest amount of damage caused to trees by alternating and direct currents

is by local burnings. (Fig. 4.) The higher the electro-motive force (voltage) the more injury is likely to occur to trees.

There is practically little or no leakage from wires during dry weather. In wet weather, however, when a film of water is formed on the bark, more or less leakage is likely to occur, and if the insulation is insufficient and contact with the tree exists, grounding takes place and burning, due to arcing, results.

No authentic cases have been observed by us where the alternating current employed for lighting service has killed trees, though there are authentic cases, extremely rare, where the direct current used in operating street railroads has killed large shade trees. (Fig. 5.) This has been accomplished by reversing the polarity, causing the positive current to traverse the rail and the return current the feed wire, which usually carries the positive.

The high resistance offered by trees and plants in general serves as a protection against death from an electrical contact. * * *

Electric currents of whatever nature, when applied to plants, of a certain intensity act as a stimulus.

The physiological effect of the direct current on vegetable life differs from that of the alternating. The latter current acts more as a stimulus to the plant than the former.

There is evidence to support the idea that a current, of not sufficient strength to cause burning, may overstimulate the plant and cause a retardation of its activities which will subsequently result in death.

Earth discharges during thunderstorms are more common than generally supposed, and they are known to disfigure and cause the death of trees. (Fig. 6.)

SOFT CORN AND ITS VALUE FOR BEEF PRODUCTION.[a]

It not infrequently happens that the corn crop is seriously damaged by early frosts, the yield per acre being much reduced and the crop made worthless from a market standpoint, since it is soft and watery. Especial interest attaches, therefore, to the work by W. J. Kennedy and associates, at the Iowa Experiment Station, carried on with a view to learning the chemical composition of such corn and its real feeding value.

After a preliminary period, in which corn fodder and shredded corn were compared for supplementing pasturage, a test was begun August 11 with two lots of 8 steers each, averaging 1,030 pounds per head in weight. From the first the steers were fed full grain rations, in one case soft corn and in the other mature corn, these grains being supplemented by pasturage and later by hay and gluten feed. At the close of the test, April 13, the steers were sold in Chicago and slaughtered. The animals fed soft corn required 9.77 pounds of corn with 3.9 pounds of hay per pound of gain, and those fed mature corn 9.36 pounds of corn and 3.44 pounds of hay, the cost of a pound of gain in the two cases being 7.92 cents and 10.95 cents. The shrinkage in shipping of the soft-corn-fed lot was 3.38 per cent, and the dressed weight 60.8 per cent of the live weight. Similar values for the lot fed mature corn were 3.47 per cent and 60 per cent.

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[a] Compiled from Iowa Sta. Bul. 75.

The soft corn used in the above trial contained a little over 35 per cent moisture at the beginning of the test and 16 per cent at its close. According to the authors the results obtained show that the soft corn was fully equal in feeding value to mature corn for fattening cattle.

Cattle fed on such soft corn made nearly as heavy gains and finished equally as well as those fed on mature corn. * * * When soft corn similar to that used in this test could be purchased for 30 cents per bushel, the prevailing market price, gains on fattening cattle could be made at a cost of 3.03 cents per pound less than when mature corn, costing 50 cents per bushel, the prevailing market price, was fed under similar conditions. * * *

The results herein presented are given to the public as the results of one year's work, not as definite and final conclusions pertaining to this important line of work. Future tests may or may not show up soft corn in as favorable a light. It is but fair to say that the corn used and grown upon the college farm was further advanced from a maturity standpoint than the so-called "soft" corn in many portions of Iowa and the surrounding States, which, no doubt, stood in its favor. * * *

That the corn was affected by the frost and of a chaffy nature is noticeable when the weight of a measured bushel is taken. An average of several tests made to determine the weight per measured bushel showed it to be but 51 pounds.

Analyses showed that both the grain and cob of soft corn contained considerably more water than similar samples of mature corn, but did not differ otherwise markedly in chemical composition. In a considerable number of analyses of samples of corn gathered from different sections of Iowa in 1902, the maximum amount of moisture present in the corn was 23.89 per cent; the minimum, 11.30 per cent, and the average, 18.83 per cent. In the case of the cob the maximum was 39 per cent; the minimum, 6.76 per cent, and the average, 27.65 per cent. As shown by these figures the variation in water content was large. According to the authors, "the amount of moisture depends chiefly upon the maturity of the corn when stricken by frost."

Corn dries when stored, and a test was made of the amount of moisture lost by four varieties in nine months from the time it was husked and cribbed. The total loss of water varied from 21.09 per cent of the amount originally present with Iowa Silver Mine to 22.05 per cent with Mammoth Red.

The question of the value of soft corn has been very frequently discussed in the agricultural press, and for this as well as for other reasons the experiments carried on at the Iowa Station are especially interesting.

HAY SUBSTITUTES.[a]

Occasionally there occurs even on the best-managed farms a shortage of hay, and the question of a satisfactory substitute for it becomes a matter of vital importance. D. O. Nourse, of the Virginia Experiment Station, has reported some interesting results of trials of various

[a] Compiled from Virginia Sta. Bul. 148.

hay substitutes—corn stover, wheat straw, and cotton hulls—with dairy cows and spayed beef heifers. "A portion of the [dairy] cows were fed dry and others wet roughage to see if the moisture would add to palatability and consequent greater consumption, and with resultant better yield of milk." The cows were given all the roughage they would eat.

The amount of stover consumed was practically the same in each case. Three out of four of the cows made a gain rather than a loss in the flow. * * *

Realizing that wheat straw would not be relished by any of the cows, we concluded to not only moisten it for one lot, but to set aside a third pair, giving them straw mixed with their silage, and feeding it after it had been mixed for a short time, to give it a chance of getting the flavor of the silage. In this we were not disappointed, for both cows ate a very considerable amount of the straw, and the yield of milk was second only to the stover-fed lot. The straw could not be easily separated from the silage by the cow, and the whole was eaten with evident relish.

Noting the conditions under which these two cows seemed to thrive, we, in February, began feeding a considerable number in our herd (about twenty cows) with silage and straw mixed. Our method of handling it was: In the afternoon, just before dusk, we placed in a room convenient alternate layers of silage and cut straw. This was allowed to remain until next morning, when the whole mass would be quite warm and the straw soft. It was fed to the cows during the day, and another lot prepared. By this means we used a large amount of straw and obviated the necessity of buying hay.

In case of the beef heifers more stover than hay was eaten. Only a very small amount of straw was eaten (17 to 31 pounds per week), and the gains were small. A larger amount of hulls was eaten, but the gains were but little larger than with straw.

Summing up the work in both tests herein described, it would seem that we can draw some quite definite conclusions, at least for this section of the State, and, with one or two modifications, for other portions of Virginia.

Corn stover can be used to excellent advantage as a roughage for beef animals, and, with a moderate amount of grain, it compares very well with others given hay. For dairy cows, and when used with silage and a moderate grain ration, it makes an admirable food. We have given a herd of dairy cows no roughage for the entire winter, except stover and silage, with grain as mentioned. The animals gave every appearance of thrift, and a good flow of milk continued. * * *

The use of straw can not be so highly commended, and yet it can serve a good purpose, especially when hay is high in price. If given more grain to make up for the deficit in quality of the straw, it will carry stock safely through a winter, and even horses may do hard work, if given the best of care. Of course, if one can get oat straw it is considerably better than that from wheat. For dairy cows, or in fact for stockers to be carried over, if they can have some silage and the straw mixed with it, as mentioned before, they are likely to come out in the spring in a very thrifty condition.

Of the cotton-seed hulls we can not speak very encouragingly for this section. As one authority states, "they are in value about equal to oat straw." From our trial we should so consider them, though we were obliged to tempt the animals by every known means before they would eat them, due very likely to the fact they had never had access to them before.

OAK LEAVES AS FORAGE.[a]

In the course of a study of the forest resources of a reserve in the northern coast-range region of California which he was making for the Bureau of Forestry of this Department, W. W. Mackie, of the University of California, observed that a large part of the actual nourishment of the stock in the region was obtained by browsing on various oaks. In view of this fact a careful study was made of the chemical composition and nutritive value of the several kinds of oak leaves usually eaten by stock, and information was collected regarding the importance of browsing forage as compared with the rapidly deteriorating grass ranges.

Five species of oak (*Quercus* spp.) found in the area surveyed were chosen for investigation. To these was added poison oak (*Rhus diversiloba*), which is very common in the region. The following table shows the composition of the leaves of these species, collected when mature, but green and vigorous, as compared with alfalfa and timothy hay:

Composition of oak leaves as compared with alfalfa and timothy hay.

[Calculated to 10.95 per cent of water.]

	Water.	Ash.	Protein.	Fiber.	Tannin.	Nitrogen free extract.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Blue oak	10.95	8.75	7.83	31.32	4.70	32.46	3.99
Scrub oak	10.95	8.72	8.48	24.83	13.03	29.11	4.87
Cañon live oak	10.95	8.92	10.11	27.21	8.88	28.52	5.41
Maul oak	10.95	9.16	7.92	28.91	9.70	30.03	3.33
Black oak	10.95	8.77	7.65	18.03	9.96	38.01	6.63
Mountain white oak	10.95	8.82	14.04	15.18	8.41	37.50	5.10
Average	10.95	8.86	9.34	24.25	9.11	32.60	4.89
Poison oak	10.95	8.15	6.44	23.65	6.04	38.64	6.13
Alfalfa	10.95	6.43	17.60	22.63	....	39.31	3.08
Timothy hay	10.95	4.53	6.07	29.87	....	46.01	2.57

The analyses show that the oak leaves are richer in ash (bone-forming material) than alfalfa or timothy. They contain less protein (muscle-forming material) than alfalfa, but more than timothy. In respect to these two constituents, therefore, the leaves compare very favorably with alfalfa and timothy as far as chemical composition shows.

In oaks the nitrogen-free extract, consisting of starch, sugars, pentosans, etc., does not equal alfalfa in any species, and in scrub oak falls as far below as 10 per cent. This fact indicates a lower fattening and heat-producing power than in alfalfa. * * *

Judging from the results of the chemical analyses of these oak leaves, they would seem to occupy a high place among forage plants. This would be the case were it not for excessive amount of three of the chemical constituents, namely, crude fiber,

[a]Compiled from California Sta. Bul. 150.

resins and waxes, and tannin. The high percentage of crude fiber taken together with the low percentage of nitrogen-free extract produces a coarser and less nutritious feed than leguminous crops. The resins have pungent and disagreeable flavors, which render them distasteful to stock. * * * As compared with the crude fiber and resins, tannin of oak leaves * * * is not only bitter and astringent, but interferes with digestion.

In summing up the value of the forage oaks, from chemical analyses and observations in the field, the conclusion is reached that the facts observed in the field coincide in most cases with those determined by analysis. For instance, the deciduous oaks possess a higher nutritive value than the live oaks, and are, as would be expected, more readily eaten by horses, cattle, sheep, and goats. In some cases, however, certain physical conditions modify these relations. This is true in the case of the live oaks. These contain a sufficiently high proportion of nutrients, and yet only sheep and goats thrive upon them. This is due to the thick, harsh leaves, with their spinescent teeth, which prevent horses and cattle from relishing them.

THE COVERED MILK PAIL.[a]

In a bulletin of the Connecticut Storrs Station, W. A. Stocking, jr., reports the results of comparative studies of the sanitary condition of milk drawn in open and covered pails.

Two kinds of milking pails were used in these experiments. One was a regular, open pail; the other was a pail with a cover of special design. An illustration of the latter is given in figure 7. It is an ordinary milk pail with a closely fitting cover, which has an opening near one side into which is soldered a funnel 4 inches in diameter having a wire gauze of fine mesh soldered across the bottom. This funnel extends slightly above and below the cover, and slopes somewhat toward the side of the pail. Another funnel, which is loose, fits inside of the first one. When the pail is to be used a few layers of clean cheese cloth are placed across the opening of the lower funnel and the loose funnel is pushed in to hold the cheese cloth in position. The whole apparatus is simple in structure and can be easily cleaned.

FIG. 7.—A form of covered milk pail.

The method of the experiment was to compare the amount of dirt in samples from the two pails. In order to have the conditions as nearly uniform as possible, two cows were chosen which gave about equal quantities of milk and required about the same time to milk. These cows stood side by side in the stable, and were milked by the same man each time. On one day cow No. 1 was milked into the open pail and cow No. 2 into the covered pail; and on the next day the order was reversed, cow No. 2 being milked into the open pail and cow No. 1 into the covered pail.

The milk in each pail was then thoroughly stirred and a sample taken and tested for the amount of dirt it contained.

The amount of dirt in the milk from the covered pail was only 37 per cent of that in the open pail, while the amount of dirt in the strained milk was 53.4 per cent of

[a] Compiled from Connecticut Storrs Sta. Bul. 25.

that in the milk not strained. In other words, the cover excluded 63 per cent, while the strainer removed less than 47 per cent. The differences in the two samples varied more widely in the latter tests than in the former. In the strained milk the amount of dirt removed depended largely upon the nature of the dirt.

By the use of the covered pail an average of 29 per cent of the total number of bacteria and 41 per cent of the acid-producing bacteria were excluded from the fresh milk. By straining the milk as soon as drawn into the ordinary open pail an average of but 11 per cent of the total number of bacteria and 17 per cent of the acid-producing species were removed.

After the milk had stood for fifty hours, at a constant temperature of 70° F., the samples from the covered pail contained a smaller number of bacteria in the majority of the tests than did the samples from the open pail, yet the covered-pail sample frequently contained the larger number. In each test the number of acid-producing bacteria was smaller in the sample from the covered pail. In the strained milk both the total number of bacteria and the number of acid-producing bacteria were larger than in the milk not strained. While the data at hand will not warrant any positive conclusions, yet it is probable that the larger numbers in the strained milk are due to the rapid growth of certain species not removed by straining which are able to develop more rapidly because of the removal of certain other species which if present would antagonize their growth.

The milk from the covered pail usually curdled somewhat sooner than that from the open pail, the average difference being about seven hours; likewise the strained milk in most cases curdled sooner than the milk not strained, the average difference being also about seven hours.

The fact that the keeping properties of the milk were not increased is of little practical value, since the milk used in these tests kept on the average nearly two and one-half days at a constant temperature of 70° before curdling. This means that it would have kept for about five days had it been kept at the usual temperatures for handling and marketing milk. This is considerably longer than milk is ordinarily required to keep.

The demand of the public at the present time is not for milk which will keep for a greater length of time, but for that which can be used as food without danger to health. It is an acknowledged fact that large numbers of children, especially in our cities, die each year of cholera infantum or of other intestinal troubles which are caused by certain species of bacteria taken into the system in cow's milk. The species of organisms which cause these troubles naturally inhabit the filth of the stable, and it is highly probable that the exclusion of this filth from the milk supply of our cities would result in greatly reducing sickness and death from this class of diseases.

The results of these tests indicate that the covered pail is much more efficient for the production of pure milk than is the straining of milk drawn into an open pail. It is quite evident, also, that to keep the dirt out of the milk in the first place is much better than to strain it out after the milking. A considerable portion of the dirt dissolves quickly in the warm milk, and thus introduces a contamination that can not be strained out.

These tests were made in a dairy where the conditions of cleanliness are good, as is shown by the small quantities of dirt found even in milk from the open pail. The use of the covered pail would doubtless prove to be even more efficient where the conditions were not so good.

CANNING CHEESE.[a]

It is quite generally conceded that the consumption of cheese is materially increased by marketing a uniform product in convenient size and form for the use of small families. Many persons who are fond of Cheddar or factory cheese consume less than would otherwise be the case because the small amount ordinarily purchased in the form of a slice cut from a large cheese dries rapidly and deteriorates in quality before it is used up. On this account efforts have been made from time to time, with varying success, to devise some better or more convenient form for marketing this sort of cheese.[b] Whatever the form or size selected, the making of first-class cheese of standard flavor is attended with many difficulties and uncertainties even when the materials used and the condition of manufacture are uniform. E. F. Pernot, of the Oregon Experiment Station, has recently studied the problem of ripening cheese, especially Cheddar, under uniform conditions in cans, hoping in this way to secure a fairly uniform product in a convenient form.

The flavor of cheese, it is believed, is very greatly affected by the growth of micro-organisms in it. Many varieties of these micro-organisms are commonly present in the air, and the sort found in the cheese is more or less a matter of chance unless special pains are taken to add pure cultures, and in the experiments reported pure cultures were used.

In the Oregon experiments the fresh milk as it was received at the dairy was weighed, placed in vats, and immediately inoculated with a pure culture of the organisms used, which had been grown in sterile milk for twenty-four hours.

When the proper acid reaction had taken place, rennet was added; after the curd was formed it was cut and heated in the usual manner until a proper acid reaction was reached, which was determined by the hot-iron test. The whey was drawn off and the curd "matted" or "cheddared" at a temperature and for a time sufficient to develop the required acidity, again determined by the hot-iron test. The matted curd was then cut, salted, and packed into cans or hoops.

Round cans made to contain 1, 2½, and 5 pounds each were procured and thoroughly cleaned. In order to protect the tin from the action of the salt and acid, the cans were first lined with parchment butter paper, but this was not entirely satisfactory, and paraffining the cans was finally adopted. This was done by placing a small amount of paraffin in the can, heating it, and revolving rapidly until the whole of the interior was coated with a thin layer. This was very satisfactory,

[a] Compiled from Oregon Sta. Bul. 78.

[b] See also U. S. Dept. Agr., Farmers' Bul. 162, p. 28.

as when the cans were opened six months after filling the surface of the tin was bright and unacted upon.

When the curd was ready for pressing it was firmly packed into the can in small quantities with a wooden instrument, similar in form to a potato masher, and the cans sealed.

The proper condition of the curd at the time of filling the cans was a matter of experiment. In order to determine this, cans were filled at regular intervals of one hour from the time the whey was drawn off until one hour after milling and salting, and it was found later that, in all cases, curd milled and canned one-half hour after salting gave the best results.

As there is no evaporation while curing, the curd must not be too wet or there will be unabsorbed whey when the can is opened. Less than the usual amount of salt must be added, because it is all retained. In curing by the ordinary method there is a constant evaporation going on which brings the salt to the surface in solution where it crystallizes, diminishing the saltiness of the cheese. The latest experiment was to press the curd in hoops in the regular manner, after which the bandage was removed and the green cheese slipped into cans which were made to fit, and covers immediately soldered on. Five-pound and 23 pound cheeses were made in this manner.

A good feature of canned cheese is the curing, which obviates the constant care incident to the ordinary method, for after the cans are placed in the curing room they require no further attention other than to keep the temperature low and constant. Humidity, dryness, vermin, or mold can not affect it.

In order to ascertain the progress in curing, lots of from 6 to 15 cans were filled at a time, so that they might be opened at regular intervals, varying from six weeks to one year.

The first can was opened six weeks after being filled, and the cheese, for its age, was well ripened, of an excellent flavor and odor, the texture was friable, delicate, and quite superior. * * * Several cans were opened at each of the various times, and a gradual increase of the delicate flavor was noticeable, but even in a can one year old it did not become strong and rank. There seemed to be a limit reached in the ripening, after which it remained unchanged. Very naturally there was no rind, no mold, and no loss in weight through evaporation; a pound of curd produced a pound of cheese.

The first lots of cheese canned were placed to cure in a small room adjoining the laboratory, which was situated upstairs in a wooden building. The temperature of this room was kept at about 60° F. until the summer months, when it reached about 75° F. All the cheese cured under these conditions was good, but unfortunately one day in early July the temperature suddenly rose to over 100° F.; the consequence was that all the [comparatively new] cheeses that were in different stages of curing were ruined. Those which were three months old or older were not affected. The younger the curd the more it was injured. Some cans sprung a leak, others swelled and even burst, and most of the unripened curd turned bitter. In several cans of fresh curd the butter fat was found to have separated from the curd.

Another lot was selected to cure at a temperature of 62° F. One month after the temperature rose to 80° F., and the cheese turned bitter. In every case where there was a high temperature in curing, or a sudden change of temperature from low to high, the cheese was spoiled. After three months' curing change of temperature seemed to have no bad effect, but by far the most satisfactory results were obtained from cheese which was cured at a constant temperature of 60° F.

Sample cans of the cheese were shipped to a number of experts for testing, the results being favorable to the canned cheese.

It would seem as if these tests fairly demonstrated that shipping had no detrimental effect upon canned cheese, but it is to be remembered, however, that the cheese must be reasonably well cured before submitting it to the extreme changes of temperature incident to shipping long distances.

The need of scrupulous cleanliness in cheese making and the desirability of manipulating it with the hands as little as possible are spoken of, the canned cheese, in the author's opinion, possessing advantages in these respects.

Means may yet be devised by which the curd will be handled with fingered paddles or other implements, doing the work of the hands, thus obviating the introduction of many objectionable germs. As an article of food for export trade or army use, cheese cured in cans would be very desirable, as it is condensed, nutritions, and in convenient form for transportation. There are others besides Cheddar cheese which could be made and cured in cans. A soft cheese having the consistency of thick cream, that could be spread upon bread, would likely find a ready market in the Orient. Some work was done in this line, but no definite results reached.

Several lots of cheese were canned without previously inoculating the milk, and they turned ont very well. Inoculating the milk with pure cultures in other lots was for the purpose of controlling the flavor and proved successful.

Good results will only be attained either way by dairymen who are competent to make first-class cheese, as the curing in cans will not correct any error made in preparing the curd.

MILLET SEED FOR HOGS.[a]

Millets are not extensively grown in the United States. If planted they are used primarily for hay, soiling, or silage. It is seldom that they are grown as grain for stock. A recent bulletin from the South Dakota Experiment Station giving the results of an experiment in feeding ground millet seed to hogs in comparison with wheat and barley is, therefore, not without interest to farmers generally.

The variety grown was hog millet, which yielded at the rate of 30 bushels of seed per acre. Barley the same season yielded at the rate of 32.7 bushels, and wheat at the rate of 10.3 bushels per acre. In the feeding test pure-bred Yorkshire hogs were used. One lot was fed ground wheat, one ground barley, and a third ground millet. Each lot was fed all they would eat of the one grain. In addition they received water daily, salt and soft coal twice per week. These feeds were fed 84 days. "It was noticed that the lot receiving millet relished their feed and were apparently in as good condition physically during the whole period as the other two lots."

For the first 56 days of the test the lot on barley gained 1.34 pounds per head daily, the lot on wheat 1.75 pounds, and the lot on millet 1.32 pounds per head daily. This shows that the gain on millet during this period was nearly as rapid as on barley. All of the hogs were in good condition at this time and were ripe for killing. During the remain-

[a] Compiled from South Dakota Sta. Bul. 83.

ing period of 28 days all ate less and gained less rapidly than during the first period. The lot on millet, however, gained least rapidly, the figures being a daily gain of 1.07 pounds for the hogs on barley, 0.76 pound for the lot on millet, and 1.51 pounds for the lot on wheat. The total gain for each hog during the whole period of 84 days averaged 105.5 pounds on barley, 95.5 pounds on millet, and 140.5 pounds on wheat.

Relative to the quality of the pork produced the station states as follows:

The color of the lean meat in the millet and wheat lots was lighter than that of the barley lot. The fat on the wheat and the barley carcasses was several shades darker than the fat made from millet; in fact, it had a yellow tinge not noticeable in the millet lot. The color of fat on the carcasses that had been fed on millet was pure white, and was pronounced by the local butcher as being of superior quality to that of the other carcasses, although not so firm in texture.

In the experiment both barley and millet had a feeding value of 41 cents per bushel, while wheat had a value of 52 cents per bushel.

The conclusions from the experiment are in part as follows:

Millet seed can be grown profitably as a fattening ration for swine. * * * On account of being so well adapted to the conditions in this State and so palatable a feed, it should have a place in the rotation of crops on every stock farm. * * * A bushel of 56 pounds of millet is equal to a bushel of 48 pounds of barley for hog feed. Millet meal produced a softer quality of fat than did either barley or wheat meal. Millet meal was found not to be so good for a fattening ration as barley meal or wheat meal during extremely cold weather.

FERTILIZERS FOR POTATOES.[a]

A thorough preparation of the soil and subsequent intensive cultivation of the crop, aside from favorable weather conditions, are not sufficient to insure a large yield in many localities where potatoes are grown for the market. An increase in the yield under such conditions is effected by the judicious use of barnyard manure and commercial fertilizers. The potato requires liberal manuring, but it sometimes happens that the applications customarily used result either in a loss or in a reduced profit because the different plant-food elements were not properly balanced, or the same quantity or quality of plant food was not obtained at the lowest cost. The results of a number of experiments throwing light on this problem of rational fertilizer treatment for potatoes are here briefly noted.

Home-mixed v. factory-mixed fertilizers.—The New Hampshire Station has recently published the results of a series of experiments mainly devoted to the study of the potato fertilizer problem. An application of 1,500 pounds per acre of a ready-mixed fertilizer was used in comparison with an equal quantity of a home-mixed fertilizer.

[a] Compiled from New Hampshire Sta. Bul. 111.

Both applications contained 3 per cent of nitrogen, 6 per cent of phosphoric acid, and 10 per cent of potash. The plant-food elements in the home-mixed fertilizer were furnished in 150 pounds of nitrate of soda, 112.5 pounds of sulphate of ammonia, 562.5 pounds of bone-black, and 300 pounds of muriate of potash. With the ready-mixed fertilizer, 279⅓ bushels of large tubers and 60 bushels of small tubers were obtained per acre, and with the home mixed, 272 bushels of large tubers and 70⅔ bushels of small tubers, the total yields being 339⅓ and 342⅔ bushels per acre, respectively. The results, so far as the yield is concerned, show but little difference, but the ready-mixed fertilizer cost $28.50 per acre, while the home-mixed application cost only $19.28, or $20.28 if $1 is allowed for mixing.

Tests of different amounts of potash.—In comparing different quantities of potash in the fertilizer application it was found that fairly good crops could be obtained on the particular soil under observation without the use of this element, and the conclusion is drawn that this soil contains a fair amount of available potash. The fertilizer in this test was applied at the rate of 1,500 pounds per acre and contained 3 per cent of nitrogen and 8 per cent of phosphoric acid in addition to the potash. The use of 150 pounds of muriate of potash or 5 per cent of actual potash in the application increased the yield by 30 bushels of marketable potatoes per acre at a cost of about 11 cents per bushel, while 300 pounds or 10 per cent of actual potash gave an increase of 46 bushels at a cost of 14 cents per bushel, and 450 pounds or 15 per cent of potash, an increase of 48 bushels at a cost of about 20 cents per bushel. These results indicate that 300 pounds of muriate of potash, or 10 per cent of potash in the application, gave the best returns. The lack of potash in the soil is often manifested by a yellowish-brown coloration of the leaves of the potato plant.

Barnyard manure for potatoes.—Experiments were also made in growing potatoes with and without barnyard manure. In some cases the manure was used alone at the rate of 15 cords per acre, and in others it was applied with commercial fertilizers varying in quantity from 750 to 2,000 pounds per acre. In every instance the use of barnyard manure, either alone or with commercial fertilizers, resulted in increased yields, the average for all tests being about 112 bushels per acre.

Where over 1,500 pounds of commercial fertilizers were used, the difference in yield was not so great and the quality of the crop not so good. The value of the manure is twofold, in that it acts favorably upon the crop immediately following its application, and also improves the condition of the soil for succeeding crops.

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